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PIGG User's Manual

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FORWARD

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This has been reviewed and is approved.

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SECTION I

INTRODUCTION

The Personal Computer Interactive Grid Generation program (PIGG) is an interactive program that aids the engineer in generating two-dimensional grids for input to computational aerodynamic codes. PIGG is capable of generating or accepting geometric data in a variety of ways and outputs grids in either binary or ASCII format. The code is run on an IBM 286 compatible computer with an Enhanced Graphics Adapter (EGA).

The user interface with the program consist of 23 command line options, eleven function key inputs and four arrow keys. New users are directed to read the "Loading and Running" notes in Appendix A before reading the remaining documentation.

SECTION II

FUNCTION KEYS

The function keys provide input while in the window mode. (The window mode is described in Section III.)

F1/F2 (ZOOM IN/OUT)

The F1/F2 function keys will make the screen zoom in or out at a rate equal to the "Movement" value displayed at the bottom of the screen. There are two versions of the code which differ in how the screen will move during zoom in, zoom out, move up, move down, move left, or move right. One version will redraw the window while visible to the user. The other version will redraw the window on an invisible screen and then swap screens to become visible when completed. The latter version of the code is to be used on high speed graphics machines only.

F3/F4 (MOVEMENT INCREASE/DECREASE)

The F3/F4 function keys will change the rate of movement of the window. The current value of the movement is displayed at the bottom of the screen. The rate at which both functions change the movement is proportional to the window dimensions. The rate of movement of the window is the rate at which the window will zoom in or zoom out and the rate at which the origin will move up, down, left, and right.

F5/F6 (DISPLAY CLEAR/REDRAW)

The F5/F6 function keys will clear all curves and grids from the window or redraw the grid. The grid will be saved in memory but the curves will not. This allows the user to clear the display with F5, move to a better viewing location, and then redraw the grid with F6. The user doesn't have to clear the display to move the window, but for large grids the user may want to to save time.

F5 TWICE (CLEAR MEMORY)

By hitting F5 twice, the user will clear the grid and all curves from memory. This must be done before running either elliptic or grid metric programs if the grid is very large (i.e. over 20,000 pts). The reason is DOS systems only allow 640k bytes of memory usage and the above two programs consume most of that memory. For 386 or 486 machines running other operating systems, this would not be a problem.

F7/F8 (METRIC DISPLAY CURVE/GRID)

A graphic metric analysis on the most recently drawn curve or grid is calculated and displayed by hitting the F7 or F8 keys.

The F7 key starts a process which calculates the following three curve metrics: the partial derivative of X with respect to Xi of the computational domain, the partial derivative of the arc length with respect to Xi, and the second partial derivative of the arc length with respect to Xi. Each curve metric will be displayed in turn in the upper left hand corner of the window. Hit the spacebar to plot the next metric. The axes are the

metric itself along the vertical axis and Xi along the horizontal axis.

The F8 key starts the Jacobian calculations of the grid which was most recently displayed. A three-dimensional graphic representation of the Jacobian versus Xi and ETA of the computational domain will be plotted. The screen can be rotated by using the arrow keys located on the number pad. Use the F1/F2 function keys to zoom in/out. The F3/F4 function keys control the rate of movement in the same way they do for the normal window mode. Hit the F10 key to return to the original window.

The main purpose of the metric displays are to show spikes or discontinuities. This may indicate poor grid spacing.

F9 (FILE DIRECTORY)

The F9 key will allow the user to list the names of files on a directory. The user will be prompted for qualifiers such as those used with the DOS "DIR" command (i.e. A:*.*, C:/PATH/*.GRD). To see all files on the current directory just hit <RETURN>.

F10 (COMMAND LINE PROMPT)

The user must hit the F10 key before performing any operations not contained in the function keys. The Command Line prompt will appear at the bottom of the screen with seven initial options. These options and their corresponding sub-options will be explained in Section III of this manual. The window can not be moved while in the Command Line mode.

SECTION III

COMMAND LINE OPTIONS

After hitting the F10 key, the Command Line (CL) will appear at the bottom with the following options:

1. DISPLAY
2. SPACE
3. MANIPULATE
4. GRID
5. CREATE
6. WINDOW
7. QUIT

Each option and its sub-options will be explained in the following sections.

DISPLAYING A CURVE OR GRID

To select "DISPLAY" type "1" and hit <RETURN>. The following options will appear.

1. GRID 2. CURVE 3. COMMAND LINE ?

To display a grid, type "1" and hit <RETURN> or to display a curve, type "2" and hit <RETURN>. The third option takes you back to the Command Line (this option will appear on each prompt and, therefore, will not be discuss further in this manual).

DISPLAY / GRID

To display a grid select "GRID" under the "DISPLAY" options. A prompt for the file name of the grid will appear as:

ENTER X,Y GRID FILE ?

Type the full name of the file and hit return. If you are not sure of the file name, make a guess and then use the directory function F9 to find the name of the file.

If the grid is larger than 16,000 points an additional prompt will appear as

(P)art or (C)ourse ?

This means the grid is to large for memory to display. You must either display part of the grid or a coarse version of the grid. Do this by selecting either "P" or "C" at this prompt.

If you select "P", you will be asked to enter the starting I,J point and the ending I,J point. If you select "C", you will be asked to enter the degree of coarseness such as 2 for every other point or 3 for every third point, etc.

A suggestion would be to use the part option when wanting to view detail closest to the body. Use course when wanting to see the grid at a far field view.

DISPLAY / CURVE

To display a curve select "CURVE" under the "DISPLAY" options. A prompt for the file name of the curve will appear. Type the full name of the file and hit <RETURN>. If your not sure of the file name make a guess and then use the directory

function F9 to find the name of the file.

When the curve is displayed, another prompt will appear asking if you want to display another. Either type "Y" for yes or type "N" for no (or hit <RETURN> for no).

SPACING A CURVE

To select "SPACE" type "2" and hit <RETURN>. The following options will appear:

1. LOWEND 2. HIGHEND 3. BOTHENDS 4. EVEN

Select one of the options by typing the number beside it and hitting <RETURN>.

SPACE / LOWEND, HIGHEND, BOTHENDS

Select either LOWEND, HIGHEND, or BOTHENDS to re-distribute points on a new or existing curve. If an existing curve is to be re-spaced, the program will spline the curve with the new spacing and desired number of points. LOWEND means the user will defined the spacing at the beginning of the curve. HIGHEND means the user will defined the spacing at the end of the curve. BOTHENDS means just that, the user will defined the spacing at both ends of the curve.

The next series of prompts will ask for information needed to complete this task. First, you will be prompted to identify if the curve you are spacing is a new or old curve. Type either "N" or "O" and hit <RETURN>. An example of the prompt and responses for spacing an old or a new curve is given below.

(O)ld or (N)ew curve? **O**
ENTER THE NAME OF OLD CURVE? **NAME1.OLD**
ENTER THE NAME OF SPACED CURVE? **NAME2.OLD**
ENTER SPACING AT LOWEST END? **.01**
ENTER NUMBER OF POINTS? **50**

OR

(O)ld or (N)ew curve? **N**
ENTER THE NAME OF SPACED CURVE? **NAME1.NEW**
ENTER THE FIRST END POINT (X,Y)? **1,2**
ENTER THE SECOND END POINT (X,Y)? **5,5**
SPACE IN X OR Y DIRECTION? **X**
ENTER SPACING AT LOWEST END? **.01**
ENTER NUMBER OF POINTS? **50**

The above is an example of responses. The prompt in both cases will be basicly the same for LOWEND, HIGHEND, or BOTHENDS spacing.

SPACE / EVEN

To get even spacing on either a new or existing curve, select "4" at the spacing prompt. The next prompts will be similar to those in section 2.2.1. The even spacing algorithm simply spaces a curve with user defined number of even arc lengths.

MANIPULATING A CURVE

The "MANIPULATE" option in the command line provides the following functions:

1. JOIN 2. BREAK 3. SCALE 4. COPY 5. ROTATE 6. REORDER

The main purpose of "MANIPULATE" is to provide the user an interactive means of manipulating curves. This is essential when building surface geometries and grid boundaries. Select an option by typing the number beside it and hit return.

MANIPULATE / JOIN

To join two curves together choose "JOINLINE." After selecting this, prompts will appear asking for the first curve and then the second to be joined. The curves must be joined so that they flow in the same direction. Thus, the second curve must start at the end of the first. To check if curves were joined correctly use the metric function F7 described in section II.

MANIPULATE / BREAK

To break a curve into two curves at a user specified location, select "BREAK" under "MANIPULATE" options. The user will be prompted to input the curve to be broken, the name for the two resulting curves, and the approximate X,Y location for the break. When prompted for the names of the two resulting curves, the curve starting at the beginning of the initial curve is considered the first curve. If one of the two resulting curves is not needed, type "JUNK" when asked for its name. This will tell the program not to save that curve.

MANIPULATE / SCALE

To re-scale a curve, choose "SCALE" under "MANIPULATE" options. The user must then input scaling factors for both the X and Y directions. To keep the same name of the curve, thus eliminating the old curve, type "SAME" when asked for the name of the new curve. Scaling is very helpful in building axisymmetric geometries or boundaries. To create a reflection image about the x axis simple use the scale factors 1,-1.

MANIPULATE / COPY

To copy a curve to another location select "COPY" under "MANIPULATE" options. Then enter the name of the curve to be copied, the new X,Y location, and the name of the new curve. To keep the same name type "SAME" when asked for the name of the new curve. The new curve will start at the X,Y location specified.

MANIPULATE / ROTATE

To rotate a curve about the origin, select "ROTATE" under the "MANIPULATE" options. A prompt asking for the curves name to be rotated will appear. Then another prompt will ask for the new curve name. To keep the same name type "SAME" for new curve name. The next prompt asks for the desired angle for rotation. For best and most accurate results, place the curve starting point at the origin, rotated it, and then move it using "COPY" to a desired location.

MANIPULATE / REORDER

To reverse the direction of a curve select "REORDER" under the "MANIPULATE" options. The user will be prompted for the name of the curve and then the name for the reordered curve. Often a curve must be reordered before joining to another curve or for preparing grid boundaries. To keep the same name type "SAME" for the name of the reordered curve.

GRID OPERATIONS

Select the "GRID" option for creating a grid, joining a grid, or outputting a grid in ASCII format. The following are grid options under "GRID":

1) TFI 2) ELLIPTIC 3) HYPERBOLIC 4) ASCII 5) JOIN

GRID / TFI

To fill the interior of a grid using transfinite interpolation, select "TFI" under the "GRID" options. Prior to selecting TFI, four boundaries or sides to the grid must already exist. In cases where opposite sides are identical, only two or three boundaries are required and the user can type "SAME" when prompted for side 3 and/or side 4. TFI only excepts boundaries in the order and direction depicted in the figure below.

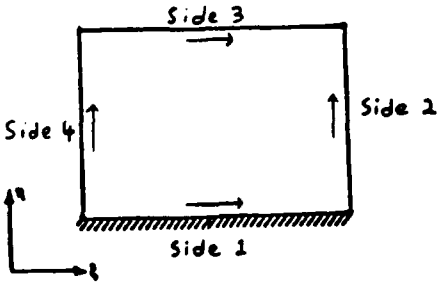

Figure 1 Computational domain.

After the grid has been created and saved to disk, it will either be displayed on the screen or if too large, a prompt will appear asking for what part of the grid is to be displayed. See "DISPLAY/GRID" for more information on displaying the grid.

GRID / ELLIPTIC

To "SMOOTH" the grid using Elliptic Possion equations select "ELLIPTIC" under the "GRID" options. Prior to selecting elliptic, an initial grid must have been created (i.e. usually an initial TFI grid). After selecting elliptic, the user must enter the grid name and the name of the new smoothed grid to be generated. Then the number of desired iterations and a convergence tolerance must be entered (e.g. 100 iterations with a tolerance of 0.01).

Of the entire PIGG program, this is the most CPU intensive. Therefore, if the initial grid is very large, expect to wait an hour or more, depending on the net CPU speed of your machine. To keep CPU speed as high as possible, no kill function exists to stop the process once started. Therefore, to stop the process, reboot the computer by hitting ctl-alt-del at the same time.

When finished, either because it converged or stopped at the requested iteration limit, the prompt will display information on convergence. If not converged, the tolerances in both the X and Y directions will be displayed. If converged, the iteration number at which convergence occurred will be displayed. In either case, hit <RETURN> to display the grid. If the grid is over 16,000 points, a prompt will appear for displaying part of the grid. See "DISPLAY/GRID" for more information on displaying the grid.

GRID / HYPERBOLIC

To create a grid using the hyperbolic grid generator select "HYPERBOLIC" under the "GRID" options. Prior to selecting hyperbolic, a body surface must be created with the desired grid spacing along the surface. The hyperbolic grid generator will produce an orthogonal grid around the surface in the form of an O type grid. The user will be asked to enter the name of the body surface, The curvature factor (cf) from .5< cf < 1., the maximum y location, maximum number of steps in J, and the desired spacing off the surface. After the grid is complete, a prompt will appear asking to display part of or a course version of the grid. See "DISPLAY/GRID" for more information on displaying the grid.

GRID / ASCII

All files produced by PIGG are in binary form. If a formatted ASCII file is needed select "ASCII" under the "GRID" options. Remember, only convert a grid to ASCII when it is in final form. Formatted ASCII grid files can become large, usually between 500 to 900 k bytes. The format for a ASCII file is simply two integer headers (i.e. Imax, Jmax), followed by a real X,Y on each following line. The format for a binary unformatted file is two real headers (i.e. xImax, xJmax) on separate lines. Then real X on the next line followed by real Y on the next line and so on.

Example for a binary grid file: (FORTRAN)

```
WRITE(2) XIMAX
WRITE(2) XJMAX
DO 10 J = 1 , JMAX
 DO 10 I = 1 , IMAX
  WRITE(2) X(I,J)
```

```
      WRITE(2) Y(I,J)
 10   CONTINUE
```

Example for a ASCII grid file: (FORTRAN)

```
      WRITE(2,*) IMAX,JMAX
      DO 10 J = 1 , JMAX
       DO 10 I = 1 , IMAX
        WRITE(2,*) X(I,J) , Y(I,J)
 10   CONTINUE
```

GRID / JOINBLOCK

To join two grids together along a common curve select "JOINBLOCK" under the "GRID" options. Prompts will ask for the first grid name and then the second grid name. The first grid name is the name of the grid which contains the starting point I=1, J=1 for the final grid. The user must then indicate the direction for joining the two grids (i.e. I or J direction). The direction the grids are joined is the direction which increases as a result of joining the grids. For example, if joining in the I direction, the I value of the final grid will be one less than the sum of the I values of the two initial grids. When joining in the I direction, J must be the same for both grids.

CREATING THE SURFACE AND BOUNDARIES

Select the "CREATE" option for creating body surfaces or curves. Under this option the following capabilities are available:

1. MANUALPTS 2. MANUALDRW 3. AIRFOIL 4. GEOMETRY

CREATE / MANUALPTS

To enter X, Y points keyed in by the keyboard, select "MANUALPTS" under the "CREATE" options. Next, enter the name for the curve about to be created. A Prompt will appear for each X, Y point. After entering all desired points, type "99,99" to quit. The curve will be displayed as it is created.

CREATE / MANUALDRW

To create a curve by drawing it on the screen select "MANUALDRW" under the "CREATE" options. Next, enter the name for the curve about to be created. The drawing marker will start at the origin and the prompt will indicate location. Use the arrow keys located on the number pad to move the marker. No points are stored while moving the marker. To store a point, draw to that point and hit "S" once. Only lines connecting stored points will remain on the screen. To start another curve hit "N" and type in the name of the next curve. When finished, hit "Q" to quit.

CREATE / AIRFOIL

To create an NACA symmetric airfoil select "AIRFOIL" under "CREATE" options. After selecting "AIRFOIL", enter the name for the curve, how many points are desired, and the airfoil thickness in fraction of cord. The top half of a unit length airfoil will be created starting at the origin.

CREATE / GEOMETRY

To create all or part of a circle or ellipse select "GEOMETRY" under the "CREATE" options. The next prompt will be:

1. CIRCLE 2. ELLIPSE

Select either "1" for circle or "2" for ellipse. Next the user must define the radius. For a circle only one radius is needed, but for a ellipse both the radius in the X direction and the Y direction is needed. An arc is then defined by entering the starting angle and the ending angle. If the entire circle or ellipse is desired use 360 to 0 as starting and ending angles. Next enter the X and Y locations for the origin and then the total number of points desired on the curve. After the above information has been provided give the curve a name.

WINDOW MODE

To return to the window mode of the program, select "WINDOW" on the command line options. The window horizontal dimension will be shown on the prompt line following "WINDOW." The actual movement of the window in screen units is shown following the prompt "MOVEMENT." The movement of the window means the change in location of the origin on a horizontal or vertical movement, and the change in window dimensions on a zoom in or zoom out. To move horizontally or vertically use the arrow keys located on the number pad. To zoom in or zoom out use the F1/F2 keys described in Section I.

APPENDIX A

LOADING AND RUNNING PIGG

LOADING:

A total of 12 files are required to load the program. Make sure you have the following files:

PIGG.EXE	: Title screen
BPC2D.EXE	: Executive
BHYPTANA.EXE	: Spacing code
HYPOGRID.EXE	: Hyperbolic Grid Generator
BSONI.EXE	: Transfinite Interpolation
BELGG.EXE	: Eliptic Grid Smoother
BJOIN.EXE	: Joining Curves
BJOINBLK.EXE	: Joining Blocks
BGJAC.EXE	: Grid Jacobian
BGJACP.EXE	: Grid Jacobian Plotting
BLJAC.EXE	: Curve Metrics
IMAG.SAV	: Title screen

Copy all above files into a directory and set the Path to that directory. Next, create a separate directory for your data and use this directory as you root. BPIGG.EXE, BPC2D.EXE, IMAG.SAV must be in the same directory as your root directory. If you have extended memory, loading the program into a Ram Drive works well but may cause memory errors if the Ram Drive does not have enough space.

RUNNING:

To start the program type **BPIGG**. Remember, always use capital case so turn on the cap lock. To get to the Command Line, hit **F10**. The program will prompt you at the bottom for each decision you need to make from here on. Keep a copy of the

function key template handy for a reference while operating the program. The Executive has good error handling but some other programs do not. If you get into any trouble just control-c or quit by normal means. Your files are written to the disk when created so they won't be lost by any unforseen events (unless you are writing them to a ram drive and the system halts, have fun making them again!).

This program is designed to put your computer to its limits in memory, cpu speed, disk speed, and disk storage. Therefore, don't be concerned if large grids take a couple minutes. If more then three minutes has gone by (except for Elliptic smoothing which may take over an hour for large grids to converge), memory has probably been surpassed and you need to reboot the system. If a large grid is in memory (i.e. 25,000 points), large programs such as the Elliptic Smoother will not load do to not enough memory. Hit **F5** twice to clear memory if you feel memory might be a problem before attempting large grid operations.